Study Committee C1

Power System Development & Economics

Paper C1-ID11003-2022

# Building a Contextualized Power System Network Model

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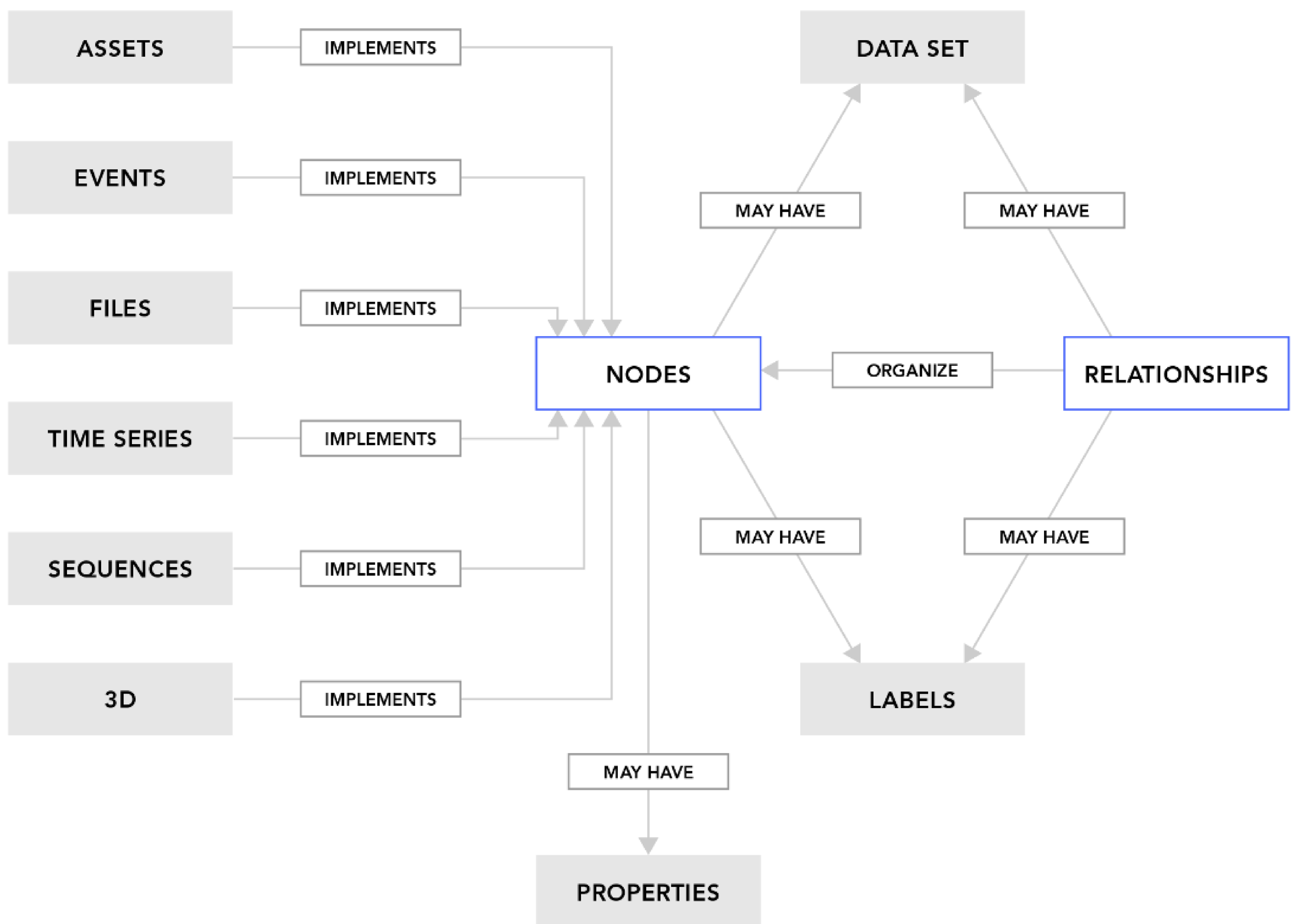
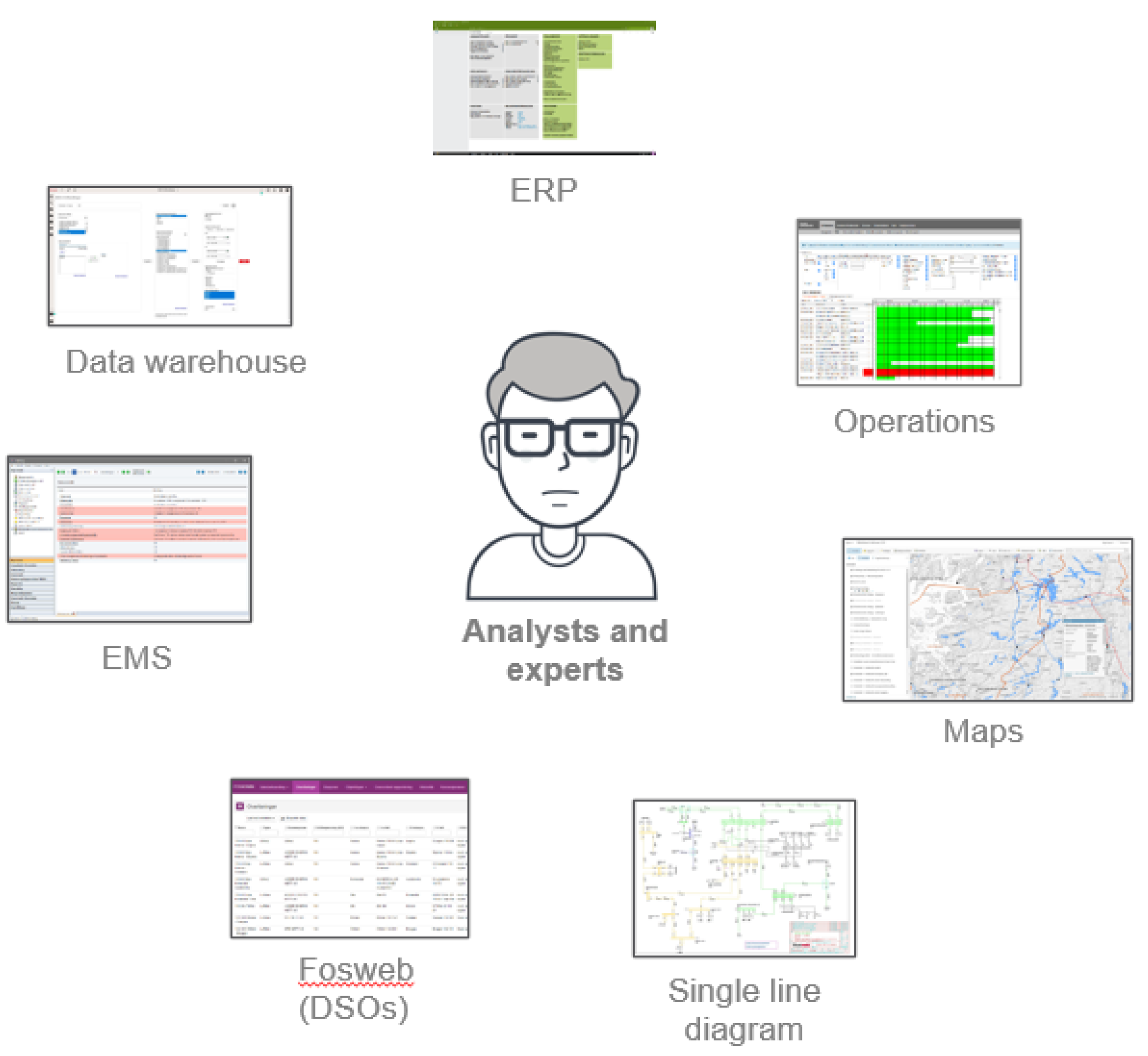
## Motivation

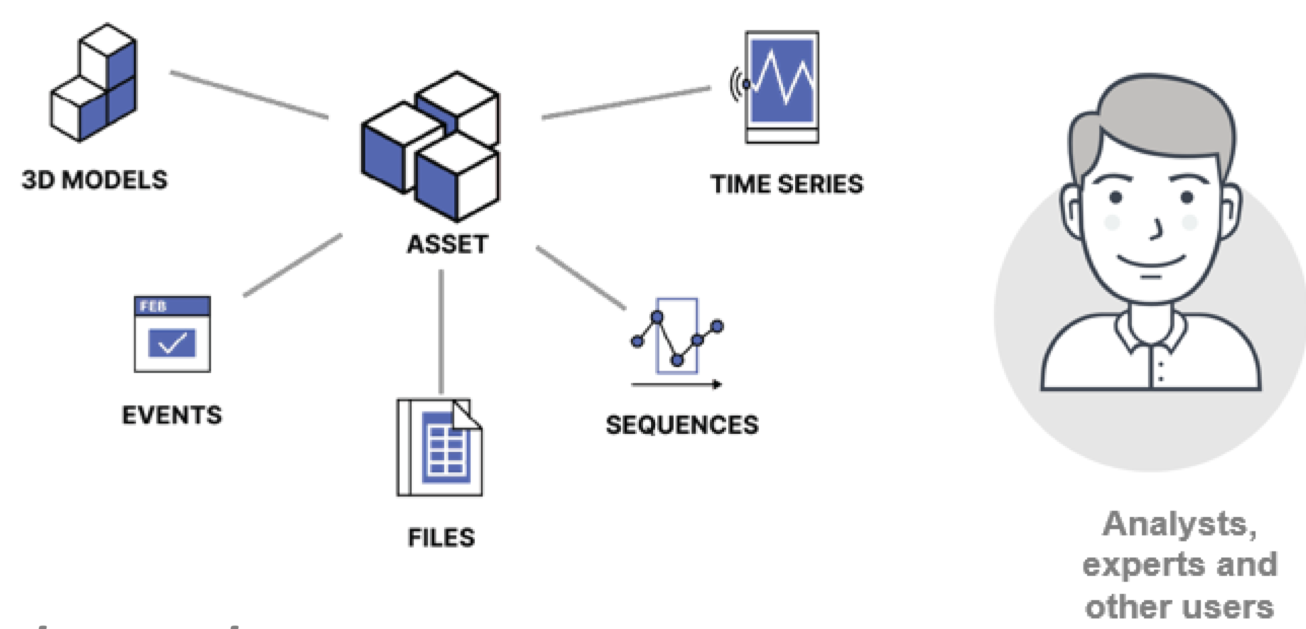
- The Norwegian grid structure is complex and conducting analysis for the best business decisions, such as grid planning and asset health assessments. often involves combining several data sources.
- Retrieving and querying data is today to a large degree static and time consuming where data is retrieved manually, and the data sources are designed around specific work processes.
- The functional power system network is modeled in adherence to the *Common Information Model (CIM)* standard.
- For the maintenance organization, however, data is organized in an *Enterprise Resource Planning (ERP)* system with a hierarchical structure.
- Combining data from different sources to conduct more accurate analysis for power system operations or long-term planning of grid asset maintenance, gives a huge value potential and can lead to smarter investment decisions and better grid utilization.
- We have worked on constructing a unified data model combining CIM and the ERP asset model with other data sources such as redispatch and market settlement data. The model is capable of tracking changes over time.

## Data model

- The vendors data platform have a set of fixed resource types that implements our unified data model.
- Nodes in the network can be represented as assets, time series and events.
- The data model is contextualized through establishing relationships between resource types and can represent the graph-based power system model.




*"From several hours of manual work to a working analysis in a few minutes"*

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# Building a Contextualized Power System Network Model continued

## Functional power system network model – CIM

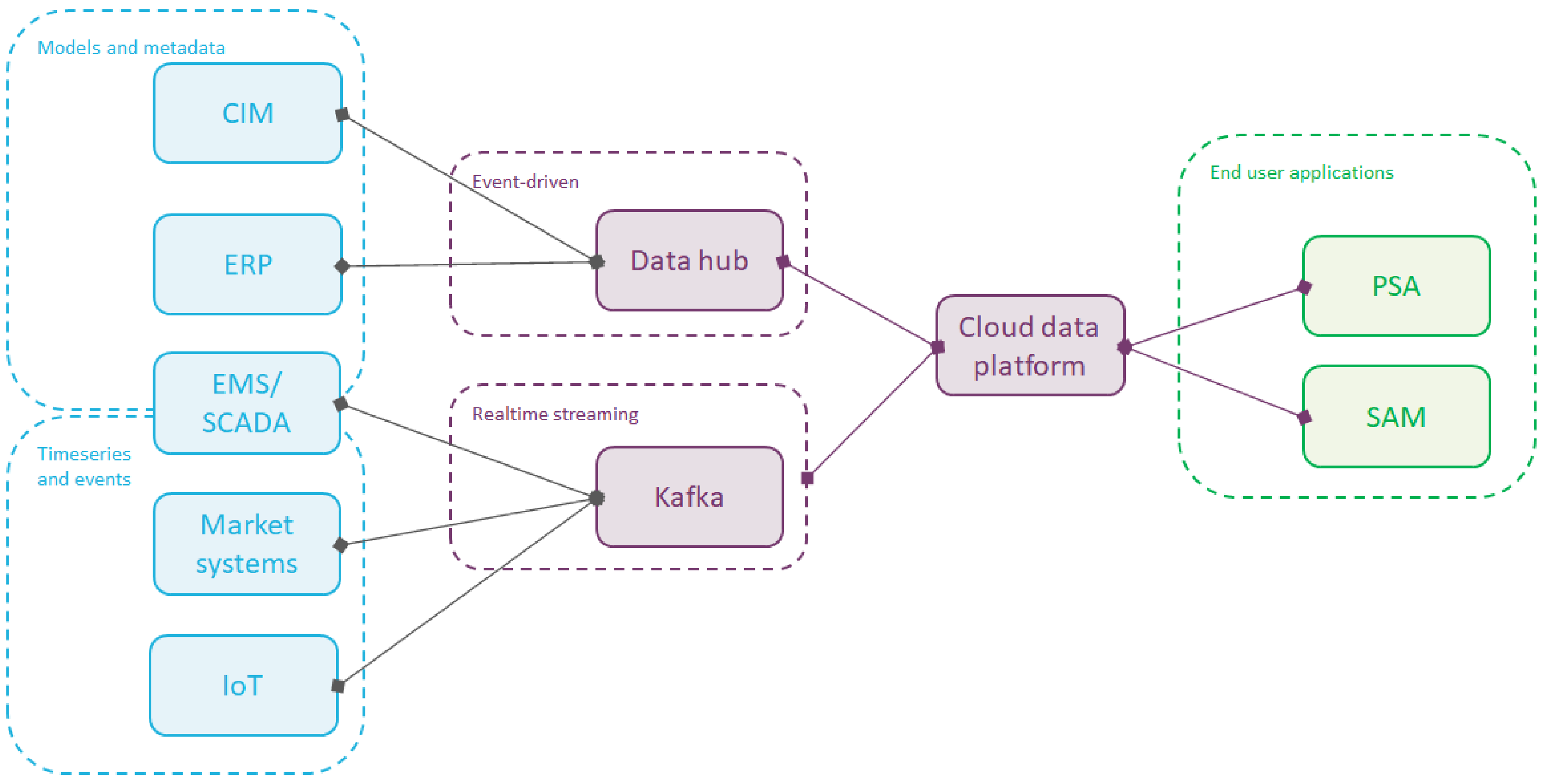
- The power system network model is modeled as a graph in CIM.
- The core of the data model is a mirrored representation of the CIM models, extended with information from additional data sources and enhanced querying capabilities.

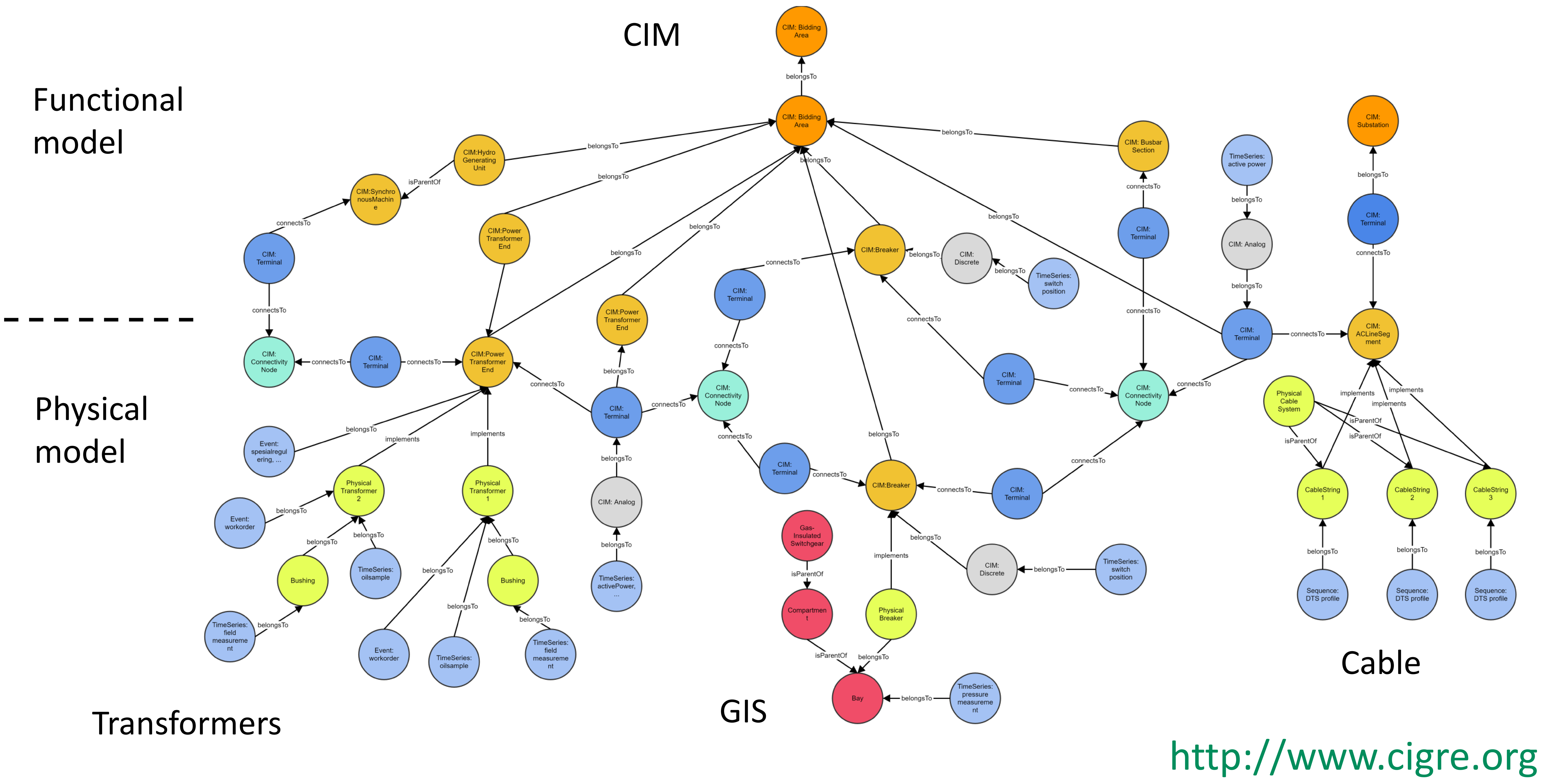
## Physical equipment – ERP

- Asset-specific information about equipment is provided by the centralized ERP system.
- Here all physical assets are described in a hierarchical model structure and are associated with metadata and additional data such as work orders.
- Until now, we have focused on modelling critical assets of the power system for predictive maintenance and asset management: *Power transformers*, *subsea cable systems* and *gas-insulated switchgear (GIS).*

## Data integration

- Data is ingested to the vendors cloud platform.
- Time series data such as data from the EMS/SCADA, market systems and other sensor data (IoT) is streamed through the real-time streaming platform (Kafka).
- ERP and CIM data are published when there is a change in the data.
- All data sources are then contextualized and made available in the cloud platform for the different tools for power system analysis and asset management.

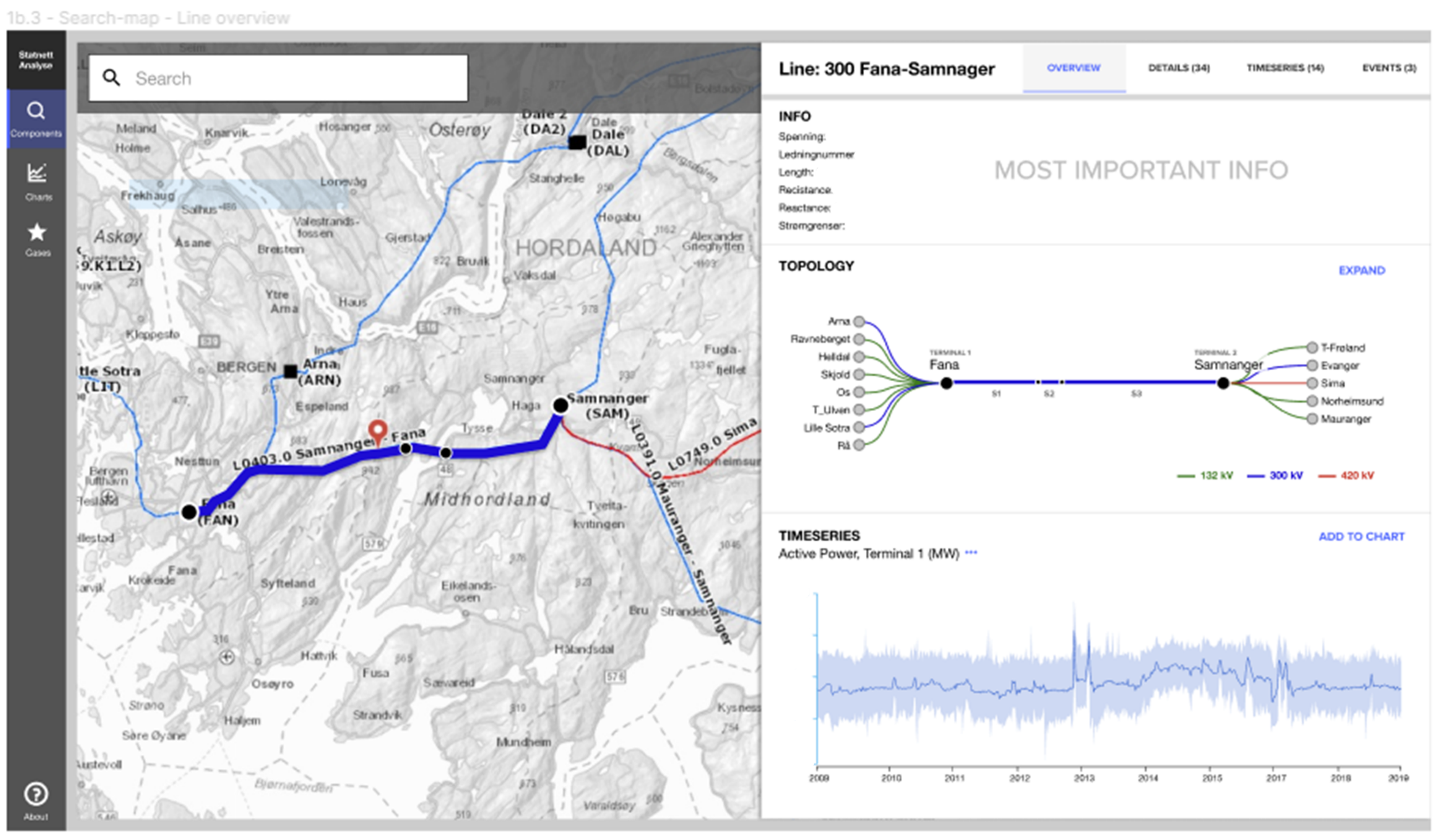


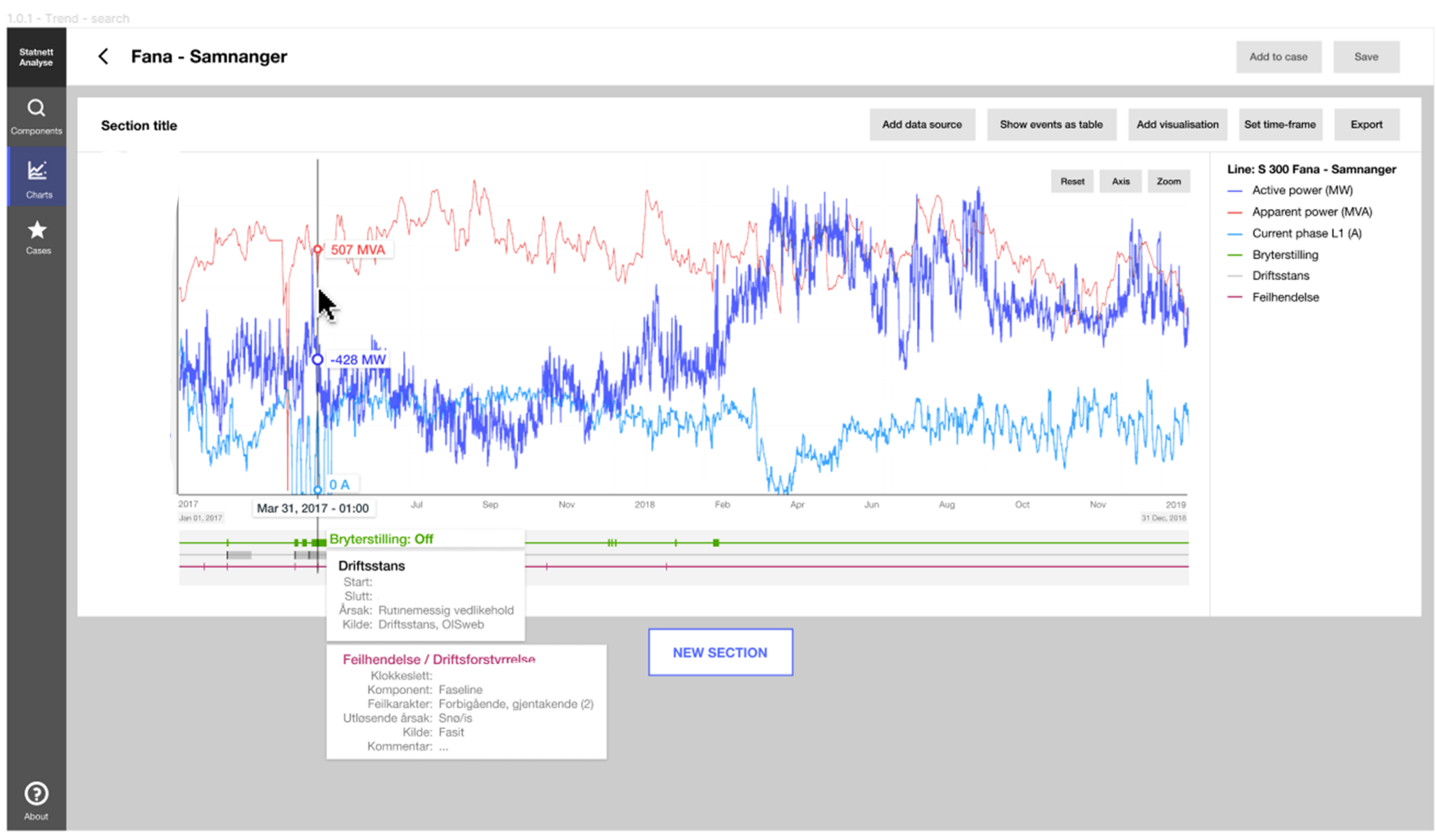



# Building a Contextualized Power System Network Model continued

## Use case: Data analysis application

- The power system analysis tool is built for the analysts working with assessing whether new customers can connect to the grid.
- The combined data is presented for the analyst and other end users in a user-friendly web framework.
- The applications also has links to other tools, such as a geographic information system.
- The relevant time series and events such as interruptions and maintenance can the ben added to a chart.




## Use case: Custom analysis in the Power SDK

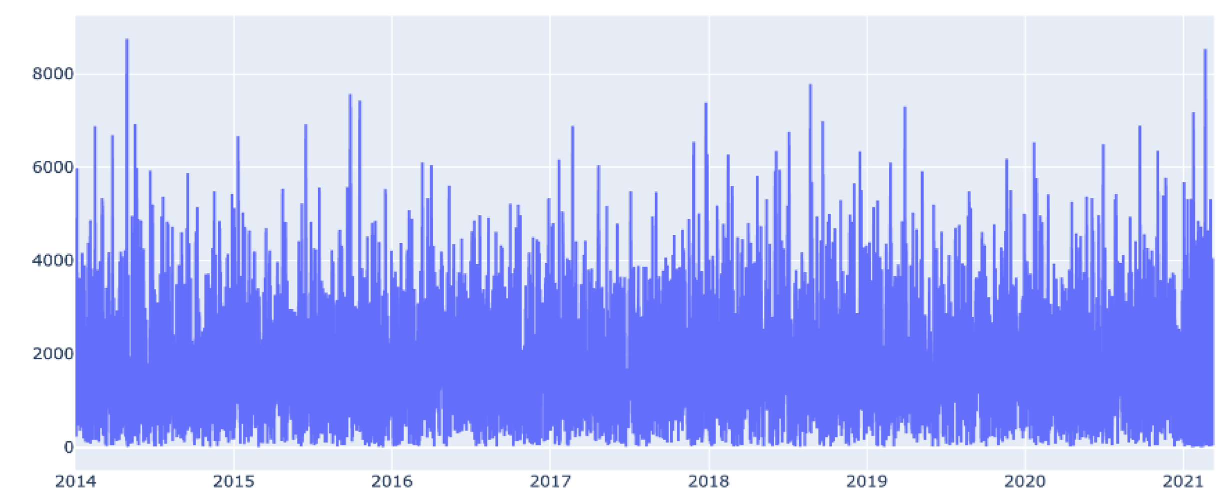
- In addition to a front-end tool, we have developed a Python *software development kit (SDK)* which enables custom advanced queries where analysts are self served for detailed studies of electrical areas, optimizing power system simulation models and performing similar analysis on numerous components.

Retrieve the relevant timeseries to assess power flow in/out of the power area:

```
In [11]: ts_area = area.interface_terminals()[0].time_series(
    measurement_type = 'ThreePhaseActivePower',
    timeseries_type = 'value')

df = c.datapoints.retrieve_dataframe(
    external_id=[ts.external_id for ts in ts_area],
    start=0,
    end='now',
    aggregates=['average'],
    granularity= '1h'
)

df.columns = [ts.name for ts in ts_area]
fig = go.Figure([go.Scatter(x=df.sum(axis=1).index, y=df.sum(axis=1), name='Power flow in/out of Power Area[MW]')])
fig.show()
```





## Conclusions

- We have built, populated and exposed a rich, *contextualized data model of the Norwegian power system*.
- A data analysis application enables the analysts to solve typical grid connection *analysis within minutes, and not using hours* of manual data extraction.
- A rich Python SDK gives the analysts the possibility to *easily do advanced quires and analysis*.